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UNITED STATES
DEPARTMENT OF AGRICULTURE

DEPARTMENT CIRCULAR 259

Washington, D. C. March, 1923

COMMERCIAL CONTROL OF CITRUS MELANOSE.[1]

JOHN R. WINSTON, Pathologist, and JOHN J. BOWMAN, Junior Pathologist, Office of Fruit-Disease Investigations, Bureau of Plant Industry.

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U. S. DEPARTMENT OF AGRICULTURE

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CAUSE OF CITRUS MELANOSE.

The blemish of the rind of citrus fruits known as melanose, or "sandpaper russet," is caused by the same organism (*Phomopsis citri* Fawcett) that causes a large part of the stem-end rot of citrus fruits. Melanose is widespread throughout the citrus belt of Florida and causes an enormous loss annually by blemishing the fruit. This reduces the market grade and lowers the sale value of the product. Therefore, the commercial control of this disease is a matter of great importance to citrus growers in Florida.

The fungus which causes melanose flourishes in dead bark on limbs, twigs, and fruit stems and in such locations produces spores in large numbers during warm wet weather. The spores ooze out in sticky masses and are carried in rain drip or dew drip to fruit and leaves. If these are in a young and susceptible condition and if moisture conditions continue to be favorable, characteristic melanose infection results. Living fruit, leaves, and twigs bearing melanose scars are not sources of infection, since the fungus never forms spores in such living tissues.

In very early stages melanose spots appear as minute circular depressions, usually darker than the surrounding normal tissue. As they age, these spots enlarge slightly and become raised and rough to

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[1] This circular contains a brief discussion of citrus melanose and gives suggestions for the practical control of the disease, taken mainly from notes on experiments and observations made during the past three years. A more complete discussion of the disease in its various phases, including inoculation experiments, together with a detailed discussion of spraying experiments, will be submitted later for publication as a bulletin. This circular is printed in advance of the issue of the proposed bulletin in order that the information may reach the fruit grower in time for use this season.

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the touch. They are mahogany brown in color and may be irregularly scattered or arranged in various patterns, such as lines, circles, or rough tear streaks. When very abundant, large areas of almost solid scar tissue may develop, commonly referred to as "mud-cake russet."

Young orange fruits are quite susceptible to melanose infection from blossoming time until they reach a size of about 1½ to 1¾ inches in diameter, and grapefruits are susceptible until they are about 2½ to 3 inches in diameter. Larger fruits are practically immune to infection. Leaves are susceptible until about the time they begin to harden and turn dark green in color.

CONTROL OF THE DISEASE.

Theoretically, melanose might be controlled by the removal of sources of infection by pruning out all dead wood. Such a method should and doubtless would give excellent results if a perfect job of pruning were done and all dead wood removed as fast as it accumulates. To prune with the required degree of thoroughness would be an endless undertaking. Especially during the season of maximum melanose infections both young and mature fruits are falling continuously and their stems are dying back. All such parts as have died recently are excellent places for Phomopsis development.

Although cutting out the dead wood as a means of preventing melanose infections in the average bearing grove has been recommended for a number of years, it has not been found commercially practicable and has not been generally adopted.

A careful experimental test of the pruning method of preventing melanose infections was made by the writers in a mature orange grove in 1921 and again in 1922. This grove was divided into several blocks, and one block was pruned each month, beginning in spring before infections had taken place and continuing until fall, well after infections had ceased. The trees were sufficiently large to carry an average of four to five boxes of fruit annually and required one to two hours each for a man to cut out the dead wood. The work was done as carefully and as rapidly as could be expected in commercial operations. It is obvious that pruning out all dead twigs and sprigs is a slow and extremely difficult operation and necessarily expensive.

Although some blocks were pruned just before fruit infections occurred, and some were repruned the second year, little or no control of melanose resulted. Therefore, it seems that pruning dead wood from normal mature trees is not likely to reduce melanose infections to such an extent that this method alone can be relied upon to afford commercial protection from this disease. The removal of such parts seems to promote vigorous growth.

It is good grove practice to prune out regularly the larger dead and dying limbs. After severe injury by storm or cold special pruning of the trees will be required.

Since the sticky Phomopsis spores would have little, if any, chance of being carried from the ground to fruit on the trees, no special disposition of fallen fruits or prunings beyond ordinary good orchard practice seems to be required.

Even if thorough pruning, when employed once or twice a year, were an effective means of controlling melanose, it could not be generally used because of the excessive cost, the slowness of the work, and the probability that the best results would be obtained from pruning just ahead of the melanose outbreaks—a time when many other operations demand attention, such as shipping late fruit and spraying, fertilizing, and cultivating the groves.

Since the season for spray applications for the citrus white fly in May coincides rather closely with the usual season of severe melanose outbreaks, it seemed to the writers that 3–3–50 Bordeaux mixture plus 1 per cent oil in the form of emulsion applied at that time would act on the white fly and at the same time reduce melanose infection.

RESULTS OF SPRAYING EXPERIMENTS.

In 1920 a series of spraying experiments for melanose control was made with standard Bordeaux-oil emulsion. Good commercial control followed a single application early in May before much melanose infection had taken place. Almost perfect results were obtained on plats sprayed twice or oftener. The results of these preliminary tests were made known to a number of county agents, State workers, and growers.

As a result of these tests spraying for melanose control was done in a number of sections of Florida during the following year (1921). At Orlando extensive spraying experiments were conducted in which a wide range of sulphur preparations was compared with 3–3–50 Bordeaux-oil emulsion and with other copper preparations. Again, good commercial control of melanose was obtained on old unpruned seedling orange trees with one application of Bordeaux-oil emulsion made at the opportune time, and almost perfect results where two or three applications were made. The sulphur sprays as a class had little or no effect on the disease. Reports from growers who sprayed with Bordeaux-oil emulsion for melanose control prior to the rainy infection period in May indicated that in general they obtained satisfactory results.

Further experiments were made in 1922 with Bordeaux-oil emulsion and other copper sprays compared with lime-sulphur solution and with applications of certain dusts. In general, the lime-sulphur solution again had little, if any, effect upon the disease; copper soap and weak Bordeaux mixtures were only partially effective, while standard strength (3–3–50) Bordeaux-oil emulsion again proved very satisfactory. The dusts either with copper or sulphur did not give control. In Table 1 are given the results obtained in a few of the experimental plats sprayed with 3–3–50 Bordeaux-oil emulsion. A thousand or more fruits were counted from each plat during October, and the percentages are calculated to the nearest whole numbers.

It will be noted that the plat sprayed on April 13 was exceptionally free from melanose, almost as much so as the plat sprayed twice, April 12 and May 10. Good commercial results were obtained on the plat sprayed May 20, while the one sprayed on June 10 was only slightly better than the unsprayed check. It is obvious from these results that the heavy infections in this grove must have occurred between May 20 and June 10. Very slight showers occurred between May 3 and May 6, and from May 21 to June 7 there was some precipitation every day, including five days with records of more than one-half inch each. Close observation in 1922 on unsprayed trees showed a fair sprinkling of melanose by May 10. This increased by degrees, but did not become severe until about May 30. It is noteworthy that a single application apparently afforded good protection on old unpruned trees from April 13 until the fruit passed beyond its susceptible stage in June.

TABLE 1.—*Results of spraying experiments for melanose control with 3–3–50 Bordeaux mixture plus 1 per cent oil on oranges at Orlando, Fla., in 1922.*

Plat.	Date of application.	Melanose infection (per cent).					
		Absent.	Very slight.	Slight.	Medium.	Severe.	Very severe.
No. 11	Apr. 13	90	5	4	1	0	0
No. 26	Apr. 12 May 10	94	3	2	1	0	0
No. 34	May 20	88	6	4	2	0	0
No. 36	June 10	0	1	12	29	56	2
Check (unsprayed)	....	0	1	6	11	75	7

Results obtained by commercial growers in various parts of Florida are of special value in determining the worth of a spray material in the hands of practical operators. These growers were guided in large measure by an article on this subject prepared in the Office of Fruit-Disease Investigations of the Bureau of Plant Industry and published in the Florida Grower, Vol. XXV, No. 11, March 18, 1922, and in the Citrus Industry, Vol. III, No. 3, March, 1922; but the work was entirely in their hands. The results are very gratifying and show that the spraying done by commercial growers in their own way is very effective against melanose. In Table 2 are presented representative results obtained in various parts of the State following the use of 3–3–50 Bordeaux-oil emulsion.

At Fort Pierce one spraying on April 15 gave almost the same results obtained with two applications. The application made May 15 was distinctly less effective. No reason can be assigned for this, since the rainfall records at Fort Pierce indicate conditions similar to those at Orlando, with most favorable infection weather after May 20. The unsprayed check was heavily infected. The tests at other points all show decidedly beneficial results from single applications made between May 1 and May 10, with such variations in degree as would naturally occur under different working conditions. It must be borne in mind that April and early May in 1922 were unusually dry over the whole of the Florida citrus belt.

Where melanose was controlled, the sprayed fruit has almost without exception developed far less stem-end rot than unsprayed fruit or fruit sprayed too late for good melanose control. The grove at Dunedin is the only one that had been pruned, and in it infection was high on the unsprayed checks in spite of their pruning.

Another point brought out in the experimental work, but not shown in the tables, is that it is apparently more difficult to prevent melanose on grapefruit than on oranges. Since the grapefruit grows more rapidly than the orange it may under certain conditions require additional applications to afford complete protection. Further experimental testing must be done before definite recommendations on this point can be made.

TABLE 2.—*Results of commercial spraying for melanose control with 3–3–50 Bordeaux mixture plus 1 per cent oil on oranges and grapefruit at various points in Florida in 1922.*

Location and number of applications.	Date applied.	Kind of fruit.	Melanose infection (per cent).					
			Absent.	Very slight.	Slight.	Medium.	Severe.	Very severe.
Fort Pierce:								
One application........	Apr. 15...	Grapefruit...	88	9	2	1	0	0
Two applications.......	Apr. 15... May 15...	....do.......	90	6	3	1	0	0
One application........	May 15...	....do.......	20	51	13	10	5	1
Check (unsprayed).....	....	....do.......	0	2	8	10	24	56
Dunedin:								
One application........	May 1...	....do.......	83	13	3	1	0	0
Check (unsprayed).....	....	....do.......	0	0	1	10	21	68
Wiley:								
One application........	May 10...	....do.......	60	22	10	6	2	0
Check (unsprayed).....	....	....do.......	0	0	2	8	30	60
Apopka:								
One application........	May 1...	Orange......	73	20	5	2	0	0
Check (unsprayed).....	....	....do.......	0	0	6	32	34	28
Winter Park:								
One application........	May 1 to 5.	Grapefruit...	77	12	7	4	0	0
Check (unsprayed).....	....	....do.......	0	7	9	17	28	39

Weather conditions prevailing during the period of infection are very important factors in the commercial control of fruit diseases, particularly citrus melanose, by spraying. The fruits of the orange and grapefruit are susceptible to melanose infection at the normal rate of development from the dropping of the petals until about June 10. Fortunately, only a small proportion of the infection usually takes place before May 1, due to the dry weather generally occurring during April. Weather records and observations in groves over the Florida citrus belt show that in only one year out of six or eight do rains occur in sufficient quantity to permit general infection before about May 1. If the grower feels that he can put on but one application this should be completed probably about May 5, but, to be on the safe side, a single application should not be counted on to afford protection for more than 30 days.

SPRAY SCHEDULE RECOMMENDED.

The following spray schedule for the control of melanose, while based on three seasons' experience, can not be regarded as final. It is the safest recommendation that can be made, however, in the light of present knowledge. Infection periods will always depend on moisture conditions, and protection must be given before these periods.

Insecticide applications must follow the use of Bordeaux-oil emulsion to prevent serious scale injury. One application of 1 per cent oil emulsion should be made the latter part of June and another in the fall if necessary. For detailed information, see Farmers' Bulletin 933, entitled "Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida."

Tentative spray schedule for the control of melanose.

Application.	Time.	Material.	Object.
A	Apr. 1 to 10	3–3–50 Bordeaux mixture plus 1 per cent oil, as oil emulsion[1]	To protect young fruit against melanose. Also effective against *la* citrus-scab infection.
B[2]	May 1 to 10	do	To protect young fruit against melanose.

[1] Three gallons of oil emulsion (Government formula or its equivalent) in 200 gallons of Bordeaux mixture gives 1 per cent of oil.

[2] This application of Bordeaux-oil emulsion will take the place of the usual white-fly spraying.

Do not fail to spray or dust for rust-mite control; otherwise the prevention of melanose is of little value because of the later russet injury.

On small properties where spraying can be rapidly completed, it may be possible to control melanose with a single application made immediately on the first detection of the disease on the young fruit. Close observation and prompt spraying are necessary if this plan is followed, and it involves a risk of failure if the attack is very severe at the outset. On larger properties, if only one application is to be given for melanose probably the safest rule is to have it completed by May 5.

The following general spray schedules for grapefruit and oranges which have been prepared jointly with W. W. Yothers, entomologist, Bureau of Entomology, indicate the least number of spray applications that reasonably can be expected to give fair protection in ordinary years against the usual fungous diseases and insect pests in Florida citrus orchards.

General spray schedules for grapefruit and oranges in Florida.

I.—SPRAY SCHEDULE FOR GRAPEFRUIT.[1]

Application.	Time of application.	Material.	Enemy.	Remarks.
A	Mar. 15 to 25 [2]	3–3–50 Bordeaux mixture plus ½ per cent oil as emulsion.	Scab, early melanose, scale crawlers, and white fly.	Only partially effective against severe scab outbreaks,[3] but a good time to spray for scab control if grower can make but one application for scab.
or				
A	do	Lime-sulphur solution, 2½ to 3 gallons in 100.	Scab, red spiders, rust mites, scale crawlers.	Has but little effect against scab, but is desirable for its effect against insect pests.
B	Apr. 5 to 15	Lime-sulphur solution, 1½ to 2 gallons in 100.	Rust mites, sharkskin, tear-stain, and scale crawlers.	Probably not necessary if lime-sulphur is used in application A.
C	Apr. 25 to May 5 [4].	3–3–50 Bordeaux mixture plus 1 per cent oil as emulsion.	Melanose, white fly, and scale insects.	Usually quite effective against melanose.
D	June 25 to July 5	1 per cent oil as emulsion plus dry soda-sulphur 2½ pounds in 100 gallons.	Rust mites and scale insects.	Very important if copper sprays have been applied during the season.
E	Sept. 1 to Feb. 1	do	Scale insects, white fly, sooty mold, and rust mites.	Not always necessary.[5]

For footnotes see end of table.

General spray schedules for grapefruit and oranges in Florida—Continued.

II.—Spray Schedule for Oranges.[1]

Application.	Time of application.	Material.	Enemy.	Remarks.
A......	Apr. 20 to May 5..	3–3–50 Bordeaux mixture plus 1 per cent oil as emulsion.	Melanose, white fly, and scale insects.	Usually quite effective against melanose; probably not necessary on rather young trees where these enemies do not appear.
B......	June 1 to 15.......	Lime-sulphur solution, 1½ to 2 gallons in 100.	Rust mites, tear-stain, shark-skin, and scale crawlers.	The critical rust-mite application.
C......	June 25 to July 5..	1 per cent oil as emulsion.	Scale insects...........	Very important if application A was used.
D......	Sept. 1 to Feb. 1...	1 per cent oil as emulsion plus dry soda-sulphur, 2½ pounds in 100.	Scale insects, white fly, sooty mold, and and rust mites.	Not always necessary.[5]

[1] This spray schedule should be expected to give reasonably satisfactory results under Florida conditions in years when the diseases and pests do not occur in unusual abundance.

[2] In the last of the bloom, when about three-fourths of the petals have fallen.

[3] For more complete information on scab control where the disease occuss in quantity, see U. S. Dept. Agr. Bul. 1118, "Citrus Scab: Its Cause and Control," or U. S. Dept. Agr. Circ. 215, "Commercial Control of Citrus Scab."

[4] At least 10 days should elapse between the lime-sulphur and Bordeaux-oil applications, to avoid danger of injury.

[5] For detailed information on the control of Florida citrus insects, see Farmers' Bulletin 933, "Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida."

PREPARATION OF STANDARD BORDEAUX-OIL EMULSION SPRAY.

Prepare 3–3–50 Bordeaux mixture in the usual way. The following plan is suggested for 200-gallon power outfits: (*a*) Prepare a stock solution by suspending 50 pounds of bluestone in a sack at the top of a 50-gallon barrel of water; (*b*) [3] slake 50 pounds of quicklime into a thick paste and make up to 50 gallons; (*c*) [3] measure out 12 gallons (carrying 12 pounds of lime) of the stock solution of lime after thoroughly stirring and pour through a strainer into the spray tank about three-fourths full of water; (*d*) after stirring the stock solution pour 12 gallons (carrying 12 pounds of bluestone) of the stock solution of bluestone into the tank *while the agitator is running;* (*e*) *add the oil emulsion while the Bordeaux mixture is being agitated.* Complete the filling of the tank with water. Three gallons of oil emulsion (Government formula or its equivalent) in 200 gallons of Bordeaux mixture gives 1 per cent of oil. Run the agitator while spraying.

Preparation of boiled-oil emulsion, Government formula.

(See Farmers' Bulletin 933.)

Paraffin oil..	2 gallons.
Water..	1 gallon.
Fishoil soap..	2 pounds.

Put the oil, water, and soap into a kettle or other vessel that will stand fire, and heat it to the boiling point. While still very hot but after removal from the fire, pump the material into another vessel with a bucket pump and then pump back again.

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[3] If quicklime is not available, 16 pounds of builders' hydrated lime may be substituted for 12 pounds of quicklime, using the following procedure instead of steps *b* and *c:* Run the agitator while filling the spray tank; when the water has risen to about the level of the agitator, sift the hydrated lime powder in gradually; by the time the tank is three-fourths full the 16 pounds should be all in and the agitator will have churned it into a suitable milk of lime. Then proceed with step *d* above.

SUMMARY.

Melanose is a fungous disease which is readily controlled by one or two applications of standard 3–3–50 Bordeaux mixture plus 1 per cent oil in the form of oil emulsion applied before May 5 in the average season.

Citrus growers generally have succeeded in controlling the disease with Bordeaux-oil emulsion.

Weak Bordeaux mixture and other weak copper sprays are not as effective as a 3–3–50 Bordeaux mixture.

Sulphur sprays as a class have little or no effect upon the disease.

Copper or sulphur dust applications have not thus far proved satisfactory against melanose.

Thorough pruning of the dead wood as a means of controlling melanose in a normal mature grove is not likely to give paying results.

Prunings on the ground and fallen fruit so far as known are not a menace to the tree and its crop as a source of melanose infection.

When melanose is controlled, stem-end rot is reduced.

Unless rust mites and scale insects are controlled later, time and money invested in melanose control are largely lost because of the development of other injury.

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